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13. ABSTRACT (Maximum 200 words)

Non-invasive characterization of mesoscopic devices is addressed with the emphasis on magnetic response. Various systems - zero-dimensional quantum dots, metal grains, billiard structures, bulk metals, etc. - are studied at low temperatures. Quantum level statistics in the magnetic field, orbital and spin magnetic susceptibilities, the inhomogeneous broadening of the Knight shift are analyzed. Major predictions are: very large inhomogeneous broadening of the Knight shift due to new orbital and spin mechanisms; strongly non-linear and large magnetic susceptibility of quantum dots and its dependence on electron-electron interactions; temperature dependence of the magnetic susceptibility of systems with fixed electron number. A new paradigm, wherein classically irregular devices are mapped to disordered electronic devices, is developed.

14. SUBJECT TERMS
Mesoscopic devices, magnetic susceptibility, Knight shift, level statistics, quantum dots, chaotic, integrable

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Statement of the problem studied

We have studied the problem of non-invasive characterization of mesoscopic devices, with the emphasis on magnetic response. In particular, we have investigated the quantum level statistics in a magnetic field, orbital and spin susceptibilities and the associated phenomena, such as the inhomogeneous broadening of the Knight shift.

Summary of the most important results

- We predicted that at low temperatures the inhomogeneous broadening of the Knight shift, both in bulk metals and in finite grains, should be much larger than expected. A number of physical mechanism account for this: a) large fluctuations of local magnetic fields due to orbital motion of electrons, b) large fluctuations of local spin density in the presence of spin-orbit interactions, c) fluctuations of spin susceptibility in a finite grain due to variations in the level spacing at the Fermi surface.
- We investigated the effects of electron-electron interactions on the parameters of a zero-dimensional quantum dot and evaluated its orbital and spin susceptibility for a range of temperatures, dot sizes, and magnetic fields.
- We developed a scaling theory of level correlations in quantum dots and its dependence on the anharmonicity of the confining potential.
- We argued that the ergodic, chaotic motion can be mapped to real-space diffusion and, consequently, the quantum properties of chaotic systems should be similar to those of disordered metals. We worked out the particulars of such mapping, that is the length and energy scales, for systems with a "billiard" structure and systems in an anharmonic oscillator potential, appropriate for quantum dots.
- We showed that for systems with fixed number of particles (canonical ensembles) the thermodynamic quantities can be expressed in terms of the correlation function of level density for temperatures larger than the level spacing, and in terms of the probability of finding levels separated by a given energy interval in the opposite limit. As a result, we are being able to evaluate spin and orbital magnetic susceptibilities, including the effect of spin-orbit scattering, in all temperature regimes both for integrable and chaotic cases.

Publications:

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"Level correlations in the magnetic field and orbital magnetic response of finite mesoscopic systems," S. Sitotaw and R.A. Serota, in preparation.

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